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# Agricultural Credit and Fertilizer Use

Richard L. Meyer
Associate Professor

Department of Agricultural Economics
and Rural Sociology
The Ohio State University
2120 Fyffe Road
Columbus, Ohio 43210

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## Introduction

Many developing countries use special agricultural credit policies and lines of credit to accelerate the adoption and intensify the usage of chemical fertilizers. This short paper analyzes two basic questions concerning the role of credit for this purpose: 1) how can credit increase fertilizer use, and 2) why does providing a line of credit for fertilizer purchase frequently result in less fertilizer use than anticipated? The recent Brazilian experience is described as an example of a country that has heavily regulated its rural financial markets in order to increase the use of modern inputs, especially chemical fertilizers.

## Brazilian Agricultural Moderization

Since the mid-1960's, Brazilian policy makers have pursued somewhat conflicting objectives regarding agriculture. On the one hand, agriculture has been discriminated against in order to accelerate industrialization and control inflation. Overvalued exchange rates, export controls, and product price controls have reduced the profitability of farming. On the other hand, efforts have been made to expand agricultural output and modernize production. Agricultural credit policies in conjunction with minimum product prices have been a cornerstone of Brazilian policies to influence factor use and product mix.

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*I am indebted to two colleagues whose ideas have been liberally used throughout this paper. Paulo F. C. de Araujo has worked with me several years to help understand Brazilian agricultural credit. Dale Adams has been a constant stimulus at OSU in the study of agricultural credit in developing countries.

The Brazilian institutional credit system is composed of private and official (partly government owned) banks. Through the National Monetary Council and Central Bank, a series of rules and regulations were put in effect beginning in 1965 to encourage banks to lend increasing amounts of government funds and their own funds to agriculture. By the end of 1976, sixteen different credit programs were in effect in one state. Each program had its specific objectives, interest rates and repayment schedule. Nominal interest rates for agricultural credit have been set at rates which have resulted in negative real rates (i.e. the annual rate of inflation has been higher than the nominal interest rate). For example, at various times the interest rate for loans for fertilizer puchases has ranged from zero to 7 percent, while inflation has generally ranged from 15 to 35 percent. Another feature of credit policies has been that nominal interest rates for small loans (supposedly made to small farmers) have been set 1 or 2 percentage points below that of larger loans on the assumption that small farmers need special incentives to borrow and repay loans.

These credit policies have resulted in a rapid expansion in institutional credit for agriculture. As can be seen in Table 1, operating loans made in 1975 totaled almost CR $40 billion (approximately U.S. $4 billion), while total loans approached CR $90 billion. The ratio of operating loans to agricultural output rose from .07 in 1960 to .37 in 1975, while the ratio of total loans to output rose from .13 to .83. The exceptionally rapid increase in 1975 was due in part to special lines of credit for coffee recuperation and drought relief.

Of special interest is the growth of chemical fertilizer consumption in recent years. As seen in Table 2, fertilizer use in 1966 was less than 400,000

Table 1. Agricultural Credit and Output, Brazil, 1960-1975

| Year | Loans Made During Year[a/] | | | | Net Internal Product From Agriculture in 1975 Cruzeiros[d/e/] (5) | Ratio of Operating Loans to Product (2/5) (6) | Ratio of Total Loans To Product (4/5) (7) |
|---|---|---|---|---|---|---|---|
| | Operating Loans[b/] | | Total Ag Loans | | | | |
| | Number[c/] (1) | Value in 1975 Cruzeiros[d/] (2) | Number[c/] (3) | Value in 1975 Cruzeiros[d/] (4) | | | |
| 1960 | 112 | 3,180 | 231 | 6,176 | 46,493 | .07 | .13 |
| 1961 | 184 | 3,280 | 285 | 6,157 | 48,252 | .07 | .13 |
| 1962 | 337 | 4,910 | 441 | 8,382 | 57,023 | .09 | .15 |
| 1963 | 416 | 4,410 | 549 | 7,267 | 50,182 | .09 | .14 |
| 1964 | 527 | 6,560 | 771 | 9,864 | 50,521 | .13 | .19 |
| 1965 | 509 | 5,730 | 666 | 8,483 | 56,875 | .10 | .15 |
| 1966 | 529 | 6,700 | 856 | 11,539 | 50,281 | .13 | .23 |
| 1967 | 633 | 9,040 | 1,029 | 14,925 | 53,415 | .17 | .28 |
| 1968 | 733 | 11,470 | 1,500 | 21,019 | 53,485 | .21 | .39 |
| 1969 | 675 | 9,624 | 1,145 | 20,718 | 56,737 | .17 | .36 |
| 1970 | 649 | 10,992 | 1,191 | 24,648 | 64,439 | .17 | .38 |
| 1971 | 686 | 12,394 | 1,253 | 28,481 | 76,126 | .16 | .37 |
| 1972 | 687 | 14,706 | 1,266 | 35,321 | 82,608 | .18 | .43 |
| 1973 | 771 | 21,288 | 1,400 | 49,852 | 95,996 | .22 | .52 |
| 1974 | 789 | 27,757 | 1,450 | 61,648 | 104,155[f/] | .27 | .59 |
| 1975 | 1,076 | 39,446 | 1,856 | 89,997 | 107,801[f/] | .37 | .83 |

a/ Source: Various Central Bank and Bank of Brazil reports. Figures represent number and value of new loans made.

b/ From 1960 to 1968, the estimates for operating loans are based on loans made by the Bank of Brazil, which was responsible for the majority of agricultural credit lent during the period.

c/ Thousands of loans.

d/ One million cruzeiros. Values adjusted by the Index "2" of Conjuntura Economica.

e/ Source: Various issues of Conjuntura Economica.

f/ Projected from the 1973 figure by compounding a 8.5 growth rate for 1974 and 3.4 for 1975.

Reprinted from Araujo, P. and Meyer R., "Agricultural Credit Policy in Brazil: Objectives and Results."

Table 2. Use of Chemical Fertilizers in Brazil, 1966-1976 a/

| Year | North & Northeast (A) | Center-South (B) | Brazil (A+B) |
|---|---|---|---|
| | (metric tons) | | |
| 1966 | 28,129 | 352,992 | 381,121 |
| 1967 | 40,559 | 407,367 | 446,926 |
| 1968 | 38,426 | 563,284 | 601,711 |
| 1969 | 52,462 | 577,925 | 630,387 |
| 1970 | 89,052 | 909,515 | 998,567 |
| 1971 | 95,041 | 1,069,994 | 1,165,085 |
| 1972 | 125,508 | 1,321,034 | 1,446,542 |
| 1973 | 158,702 | 1,730,612 | 1,889,314 |
| 1974 | 165,222 / | 1,611,360 | 1,776,582 |
| 1975 | 128,357 / | 1,559,808 | 1,875,739 |
| 1976 b/ | 240,000 / | 2,160,000 | 2,400,000 |

a/ Expressed in Nutrients. Use of Fertilizer = Domestic Production + Imports.

b/ Preliminary data.

Sources: Araujo, et al. (1974) and Prognostico Centro-Sul, 1976-1977, IEA (1976).

metric tons. Consumption increased six-fold to approximately 2,400,000 metric tons in 1976. The steady growth in consumption slowed in 1975 due to high international fertilizer prices, but the price increase at the farm gate was alleviated by a 40% subsidy made available to purchasers through the banking system.

There is no clear way of knowing the extent to which this rapid rise in fertilizer use was attributed to agricultural credit. In the same time period, fertilizer companies rapidly expanded the marketing system to make fertilizer supplies more accessible to farmers. Fertilizer salesmen aggressively competed for clients and played an extremely important role in disseminating information about fertilizer use, costs, and returns. But, an important element in their sales strategy was their ability to assist the farmer in obtaining credit for the purchase. Thus, it is unlikely that fertilizer use would have grown as rapidly as it did without the ready availability of cheap credit.

The next section includes a discussuion of how credit can affect the amount of fertilizer a farmer uses.

## Economic Optimum Levels of Fertilizer Use

The impact that expanded agricultural credit supplies can have on fertilizer use can be analyzed through standard production economic analysis. The central concept involves relating the financial returns from fertilizer application to its cost to the farmer.

Figure 1 presents the standard assumed relationship between quantity of fertilizer used and the value of the additional crop output produced, holding all other factors of production constant. It may be easiest to think of the figure in terms of a hectare of corn. All other inputs to produce corn are held constant except fertilizer (ignoring the labor and other costs associated

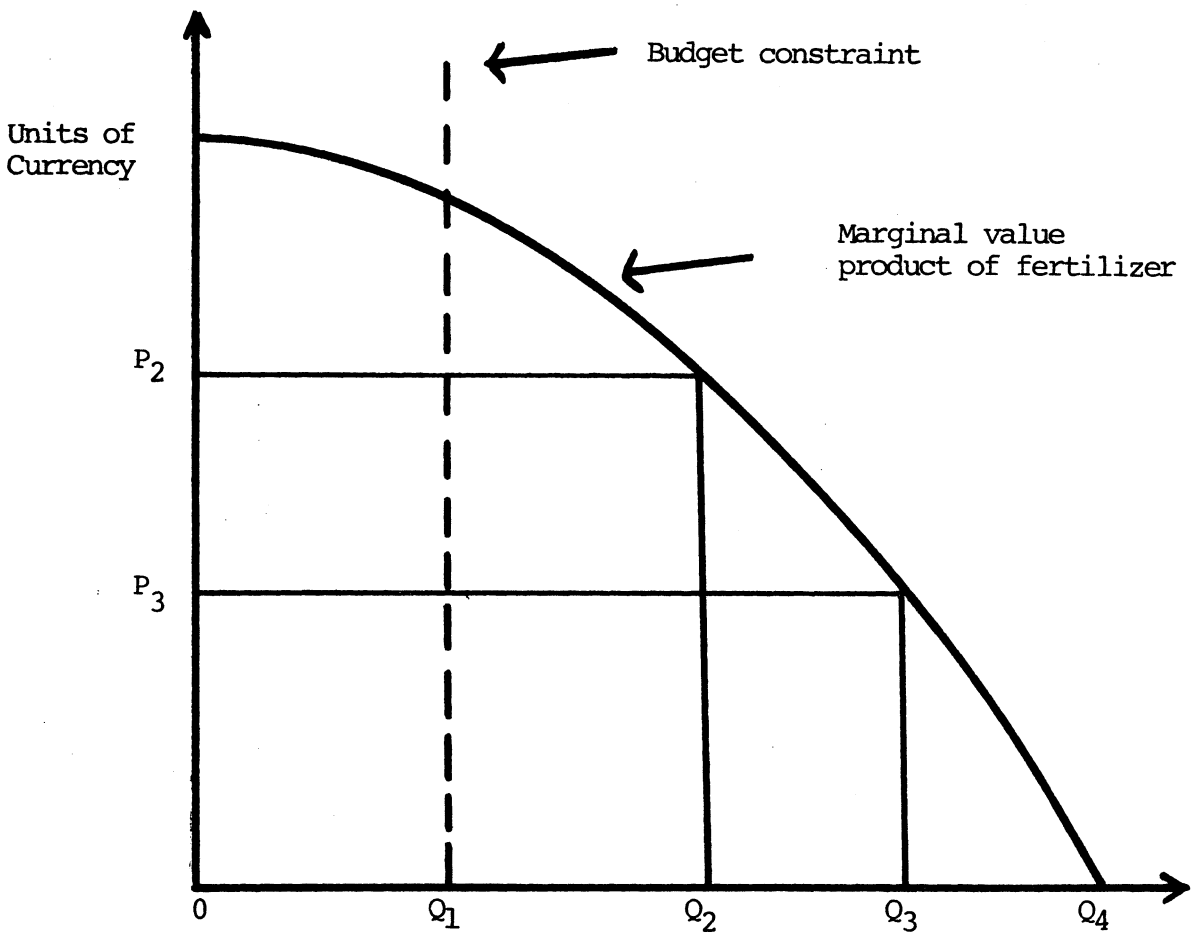



Figure 1. Marginal Value Product of Fertilizer

with applying fertilizer and harvesting additional production). The curve labeled marginal value product of fertilizer represents the additional (or marginal) amount of corn produced by each additional (or marginal) unit of fertilizer applied to the hectare of corn multiplied by the price of corn. The curve is downward sloping to indicate that successive increases in fertilizer result in successively smaller increases in corn yields, a condition which is generally assumed to exist after some level of fertilization is reached. At some point, (represented by $Q_4$) additional fertilizer use results in a decrease in total yield.

If a farmer is economically rationale and knows with certainty the productivity of fertilizer and corn prices, there is an optimum level of fertilizer use. That level is obtained when the marginal value product of fertilizer (MVP) is just equal to the cost of the fertilizer used, or the price of fertilizer if we assume the farmer's fertilizer price (P) is constant irrespective of quantity used. For example, if the fertilizer price is equal to $P_2$, then the optimum useage is $Q_2$ where MVP = $P_2$. At any point to the left of $Q_2$, MVP $> P_2$ meaning that the returns from using an additional unit of fertilizer are greater than its price. Thus, a farmer would be encouraged to use more fertilizer. However, at any point to the right of $Q_2$, MVP $< P_2$ so the farmer would be inclined to use less fertilizer. Likewise, if fertilizer prices drop to $P_3$ the optimum level of fertilizer use increases to $Q_3$.

One more condition must be met, however, if a farmer is to actually use the optimum levels of fertilizer identified above. He must have the financial resources required to buy the fertilizer. These resources are available from three sources: 1) his own liquidity, 2) trade credit from a fertilizer dealer that permits the farmer to buy on time, and 3) loans from institutional

or noninstitutional sources of credit which provide cash to purchase fertilizer. In the absence of trade credit or loans, a farmer may have only enough liquidity to purchase $Q_1$ units of fertilizer, only half the optimal level when fertilizer prices are $P_2$. Thus, the farmer's budget constraint may prevent him from using as much fertilizer as desired. By increasing credit, a quantity effect may be achieved. That is, the farmer may be able to purchase optimal fertilizer quantities when his total liquidity is increased with credit. Notice that this effect could occur with both trade credit or loans.

An additional price effect can often be achieved through institutional credit. Several countries, like Brazil, control interest rates on institutional credit at negative real rates. The net effect is that the real price of fertilizer falls for the farmer that purchases fertilizer with credit. It is similar to a price decline from, say, $P_2$ to $P_3$ with the resulting increase in optimal fertilizer use from $Q_2$ to $Q_3$.

Suppose, for example, that a Brazilian farmer borrows CR $1000 for fertilizer at a 7% nominal annual interest rate for 6 months. At the end of the loan period, he repays CR $1035. Suppose, furthermore, that the rate of inflation is 10 percent in the same period. At the time the loan is repaid each cruzeiro is worth 90 percent of its previous value, so the real value of the CR $1035 is approximately CR $930. This decline in purchasing power of the cruzeiro in effect represents a CR $70 discount on the fertilizer price. Therefore, a farmer who borrows to buy fertilizer receives a discount not realized by the cash customer.

It might be concluded at this point that increased fertilizer use is directly related to the quantity and terms of agricultural credit made

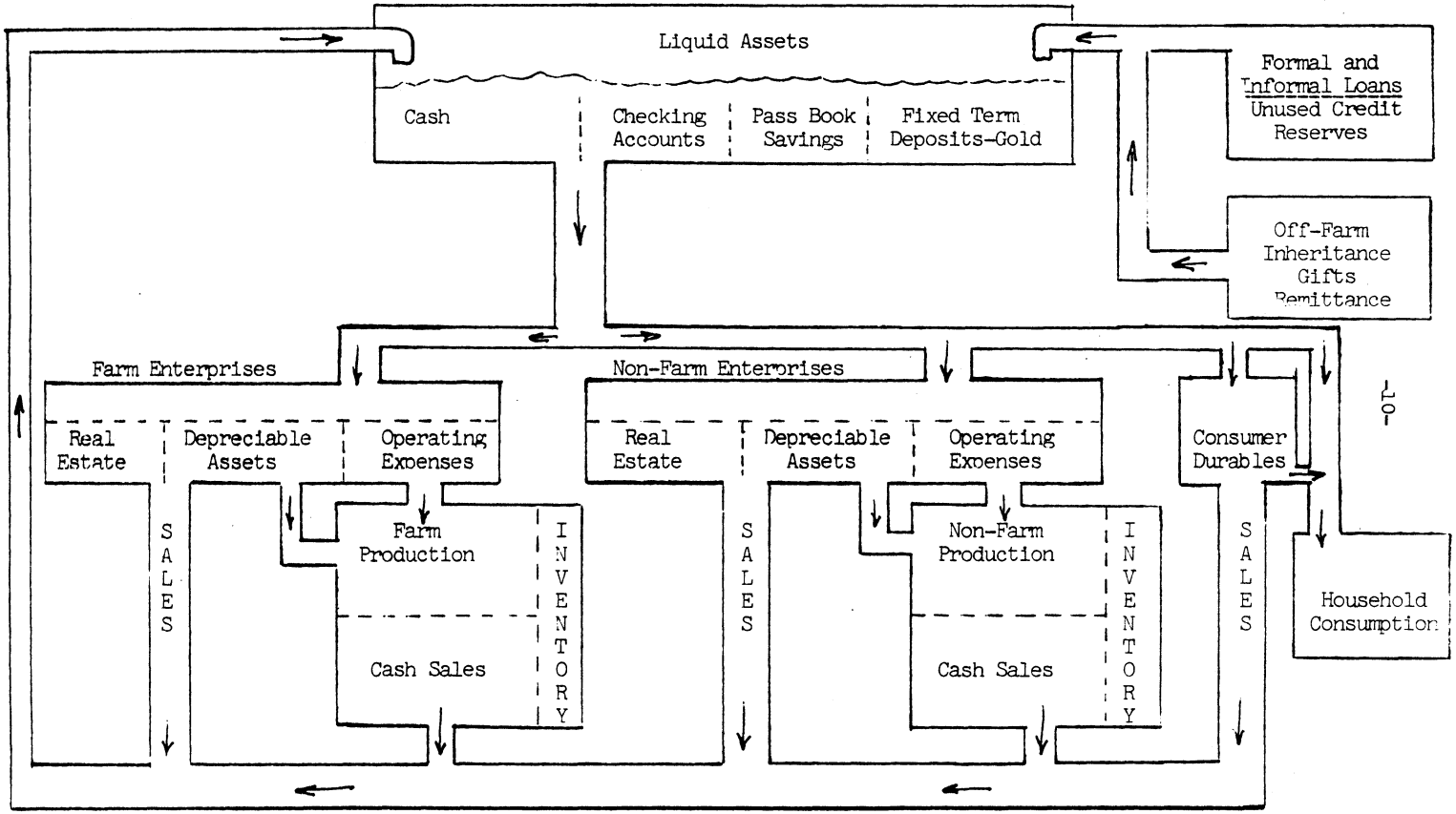
available to farmers. This is an assumption frequently made by policy makers when setting up credit programs. A serious mistake is made, however, by assuming such a direct relationship between credit and fertilizer. In fact, under certain conditions, a farmer may borrow funds earmarked for fertilizer but may increase his fertilizer use very little. That possibility is discussed in the next section.

## Credit as a Source of Household Liquidity

The standard economic analysis used above ignores the fact that the typical rural household has several sources of, and uses for, liquidity. Adams and other researchers have used a hydraulic anology such as in Figure 2 to describe this point. Notice first that a household has various forms of liquid assets. These assets are complemented by off farm liquidity sources such as earnings, gifts, etc., and borrowings, both formal and informal loans. These borrowings include trade credit as well as loans. All these sources of liquidity enter and are controlled by the household. Once a unit of currency enters the income stream, it becomes indistinguishable from a unit from another source, and can be used like any other unit for household expenditures and investments. That is, units of currency are fungible.

The other important feature of household behavior demonstrated in Figure 2 is that a typical household engages in several activities which use liquidity. These activities include household consumption, financing operating costs (including fertilizer) for farm enterprises, financing operating costs of non-farm enterprises, and long term farm and non-farm investments. Each one of these activities produces a certain satisfaction or utility to the household. The relative utility of each may be quite different at any one point in time.

FIGURE 2: Sources and Uses of Farm-Household Liquidity




Adapted from: John A. Hopkins and others, Financial Management in Agriculture (Danville, Illinois: Interstate Printers and Publishers, 1973) p. 138.
Reprinted from: Adams, D., "Policy Issues in Rural Fiance and Development".

The household reaches equilibrium in its use of funds when the marginal utility of the last unit of currency expended on one activity is equal to the marginal utility of an additional unit expended on any other activities.

Suppose that a farmer expects a high utility from using fertilizer due to the expected returns. He may be able to reallocate existing liquidity in order to purchase fertilizer. If his total liquidity is large enough or the household is flexible enough in allocating liquidity, he may be able to finance optimum levels of fertilizer use. If not, by using trade credit or loans, he may be able to acquire enough additional liquidity to purchase the fertilizer.

Suppose, however, that the farmer already plans on purchasing an "optimum" amount of fertilizer using existing liquidity. This "optimum" may be the economic optimum described above, or some other level the farmer has decided upon based on some decision criteria. It might be no fertilizer at all if he is skeptical about its impact on yields or uncertain about weather, prices, etc. Providing the farmer additional liquidity may substitute for farmer's own funds in the purchase of the "optimum" amount of fertilizer. The liquidity released is then available for other alternatives. Secondly, if the terms of the credit are favorable enough relative to the utility of expenditures for other alternatives, credit for fertilizer may be diverted to other uses. The higher the expected utility from these expenditures, the greater will be the farmer's temptation to divert the credit. Policing credit use will be difficult. Even providing fertilizer in kind, as is frequently attempted, may not effectively resolve the problem if the farmer is able to resell it.

Substitution and perhaps some diversion have occured in Brazilian fertilizer loans. The total quantity of fertilizer supposedly financed by institutional credit has been reported to exceed actual fertilizer consumption in some years.

There have been isolated reports of fraud when fertilizer dealers exaggerated the amount of fertilizer sold to a farmer so he qualifies for a larger loan.

These problems should be expected when credit is lent at such favorable terms as in Brazil. They should be expected, however, whenever the cost of credit is low relative to the utility of additional household liquidity. Substitution and diversion can occur even when real interest rates are relatively high. A household is rationale to allocate liquidity to those alternatives which promise most utility. The use of fertilizer must promise high utility if the household is to use scarce liquidity on fertilizer purchase versus several other alternatives. When policy makers ignore this point, they deceive themselves by reporting that a certain amount of credit was responsible for the consumption of a specific amount of fertilizer. It is impossible to estimate precisely what consumption would have been without the credit, but it is unrealistic to think it would have been zero.

## Conclusion

This paper attempts to show, first, how additional household liquidity through fertilizer trade credit or loans can increase a farmer's use of fertilizer by reducing his budget constraint. The increase in fertilizer use can arise from either the quantity or price effect of credit. The second part of the paper, however, suggests that there is not a direct relationship between increased credit and increased fertilizer consumption. Depending on the alternatives available to the household, increased liquidity may affect fertilizer use very little if at all. Credit may substitute for other liquidity intended for fertilizer purchase, or may be diverted to other uses.

In Brazil, the major expansion in institutional credit in recent years probably contributed to the rapid increase in fertilizer use. However, the credit specifically earmarked for fertilizer probably did not result in an equivalant increase in fertilizer consumption. This is the case in most countries. Credit may be extremely helpful in assisting farmers to use their "optimim" use of fertilizer. But that "optimum" may be far different than the economic optimum determined in standard economic analysis.

References

Adams, Dale W., "Policy Issues in Rural Finance and Development," Paper No. 1, Conference on Rural Finance Research, San Diego, July 28 - August 1, 1977.

Araujo, Paulo F. C. de and Richard L. Meyer, "Agricultural Credit Policy in Brazil: Objectives and Results", Paper No. 23, Conference on Rural Finance Research, San Diego, July 28 - August 1, 1977.

Araujo, Paulo F. C. de, et. al., "Crescimento e Desenvolvimento da Agricultural Paulista," Agricultura em Sao Paulo, Tomo III, 1974, 169-199.

Instituto de Economia Agricola, Prognostico Regiao Centro-Sul 76/77, Sao Paulo, 1976.